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Title:

Ecological Monitoring: Outreach to Educators in the Community

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Ecological Monitoring: Outreach to Educators in the Community

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Abstract

Reporting Environmental Data was a one-week institute for elementary and middle school teachers and principals. Participants gained insight into Los Alamos National Laboratory's environmental monitoring programs through performing monitoring in the field. A teacher educator collaborated with a plant ecologist, an entomologist, and two master teachers to provide this institute.

During the institute, there were field experiences with forest and insect sampling followed by research and summarizing results. Insect sampling was performed at upper and lower elevations in the same canyon. Participants set a series of pitfall traps. Two days later, the samples were collected. These insects were identified using a field guide along with assistance from the entomologist. Discussions before, during, and after the insect sampling activity focused on how certain insects provide scientists with information on the environmental conditions of a region. Participants, led by a plant ecologist, conducted tree sampling in mixed conifer and ponderosa pine regions. Transect lines were laid to mark sampling locations. Within those locations tree species were identified, tree diameters were recorded, and the percent of coverage (the canopy) was determined. The integrated discussions elaborated on fire ecology as it relates to forest density and restoration of landscapes. A third portion of the institute had small groups of participants conduct further research using the Internet, then write a technical summary which included graphs of data.

The goals for the institute were all met. These included the following: have scientists lead field experiences with forest and insect sampling which mirror their actual laboratory practices; create understanding of the broad scope of the environmental monitoring program at Los Alamos National Laboratory; establish links between the professional standards for science and mathematics education and institute activities, use computer technology as both a research tool and to produce a technical summary; and create educational environments. Throughout the institute, participants wrote journal entries; these focused on integrating environmental sampling into their classrooms and describing how their view of the Laboratory changed through experiences during the institute.

Los Alamos National Laboratory is very interested in continually improving communication with the surrounding community, especially when that communication deals with environmental surveillance. The summer institute was an effective way to involve teachers in hands-on experiences with environmental monitoring. This, in turn, taught those educators about the extent of environmental monitoring. Now those teachers are using their experiences to develop curriculum for students.

1.0 Introduction

A one-week institute for elementary and middle school teachers was held at Los Alamos National Laboratory (LANL or the Laboratory) during the first of June 1996. The five goals of the institute were as follows:

- Have scientists lead field experiences which mirror their actual field work;
- Create understanding of the broad scope of the environmental monitoring program at LANL;
- Establish links between the professional standards for science and mathematics education and institute activities; and
- Use computer technology as both a research tool and to generate graphs for a written technical summary;
- Create educational environments.

1.1 Audience

The 29 participants were teachers or administrators from small urban or rural New Mexico public schools with kindergarten through eighth grade student populations. Funding for the participant related costs was provided by New Mexico's Statewide Systemic Initiative for Mathematics and Science Education (SIMSE), which is mainly funded by the National Science Foundation and funded to a lesser extent by the New Mexico Commission of Higher Education. SIMSE selected the participants for this institute based on their rating this institute as one of interest. (Note: During the summer of 1996, this institute was one of the twelve distinct SIMSE institutes held in New Mexico.)

1.2 Instructors

The institute coordinator has 25 years of teaching experience, holds a Ph.D. in mathematics & teacher education, and is a LANL technical staff member who heads the Environmental Reports Team. One of the master teachers is a computer specialist at the local middle school in Los Alamos. The computer room at that school was used for the technical writing and research via the Internet activities. The second master teacher is a high school biology instructor in the nearby community of Española. Leading the field work sampling and identification activities and related discussions were two LANL technical staff members: one is an entomologist who is completing a Ph.D. in Ecology; the other is a plant ecologist with 20 years field experience and is an adjunct university professor. Both of these scientists have substantial experience working with educators and have received excellent reviews from their audiences. (Note: When selecting scientists as presenters, an important consideration is previous experiences effectively relating to this type of audience.)

1.3 Location

The institute was held at the Laboratory, which is located in northern New Mexico, approximately 35 miles north of Santa Fe. The geology and ecology is diverse. The altitude ranges from 5400 ft at the Rio Grande to approximately 10,000 ft at the top of the Jemez Mountains. The Laboratory is situated on a skirt-like plateau which is dissected by mesas and deep canyons. Six vegetations types: pinon-juniper, mixed conifer, ponderosa pine, juniper-grassland, spruce-fir, and subalpine grassland are well-represented in the Los Alamos environs. Hundreds of species of wildlife, ranging from aquatic invertebrates to large mammals, reside on or nearby Laboratory property.

1.4 Professional Standards for Science and Mathematics Education

Following each of the institute activities, discussions were held. One integral aspect of these discussions was how the *National Science Education Standards* and the

Curriculum and Evaluation Standards for School Mathematics are part of the hands-on learning that takes place during the institute. These professional standards for science education include strands such as characteristics of organisms; organisms and environments; systems, order, and explanation; and science as inquiry. Mathematics education standards integrated during the activities included statistics and probability, measurement, spatial sense, estimation, and mathematical connections. The participants discussed these standards and used their journals to provide written feedback of their understanding of how these intertwine with hands-on teaching and learning.

2.0 Institute Activites

There were four major institute activities, collecting of insects, sampling of forest components, writing journal entries, and using computer technology to communicate results.

2.1 Collection of Insects

Ecological monitoring of a particular area often includes collection of arthropod (includes insects) data. Biologists at LANL have been conducting insect studies for the last six years in order to assess the Laboratory influences on surrounding organisms. Insect data is relatively inexpensive to gather while providing a plethora of valuable information. As part of this institute, participants were involved in a small-scale study comparing the arthropod populations of two vegetative zones.

2.1.1 Description of the Study Sites

The trapping sites were located in a canyon bottom in two separate habitat types; ponderosa pine and Riparian/Mixed-Conifer.

The lower trapping site was characterized by an open ponderosa pine (*Pinus ponderosa*) habitat with lesser amounts of juniper (*Juniperus monosperma*). Common shrubs include mountain mahogany (*Cercocarpus montanus*) and oak (*Quercus* spp.). Understory species were more sparse and included mostly grasses such as smooth brome (*Bromus inermis*). The area experiences intermittent water flow during storm events.

The upper trapping site is characterized by mixed-conifer vegetation and stream-side vegetation (riparian). The overstory includes Douglas fir (*Pseudotsuga menziesii*), boxelder maple (*Acer negundo*), and ponderosa pine. Shrubs include oak, and Colorado barberry (*Berberis fendleri*). The understory species include several species of grasses and forbs. This area has intermittent water flow.

2.1.2 Methods

Data was collected over a 48-hour period. Insect pitfall traps were used to capture terrestrial arthropods. The pitfall traps consisted of 10 oz. plastic cups buried in the soil at ground level (Figure 1). A small amount (1 to 2 oz.) of propylene glycol was placed in the cups so that any arthropod that fell into the trap would be killed and preserved. The participants placed 50 traps in the lower site and 50 traps in the upper site. Traps were placed in a 5 by 10 grid with a minimum of 10 meters between each trap. Traps were purposefully placed in a variety of areas within the grid (i.e., under different species of trees, in the open, etc.) to ensure the collection of a representative insect sample. The traps were left open for a total 48 hours. At the end of the 48 hours all the arthropods were collected and later identified. All arthropods were identified to Order and most were identified down to Family using a field guide.

Figure 1. Standard pitfall trap used in collecting terrestrial arthropods.

2.1.3 Results

The following arthropods were identified and incorporated into the study:

Order Thysanura (Bristletails)
Order Orthroptera (Grasshoppers and Crickets)
  Family Acrididae (Grasshoppers)
  Family Gryllidae (Crickets)
  Family Gryllacrididae (Camel Crickets and relatives)
    Subfamily Rhaphidophorinae (Camel Crickets)
    Subfamily Stenopelmatinae (Jerusalem Crickets)
Order Homoptera (Plant Hoppers and relatives)
Order Hemiptera (True Bugs)
  Family Rhopalidae (Boxelder Bugs)
Order Lepidoptera (Butterflies and Moths)
  Suborder Rhopalocera (Butterflies)
  Suborder Heterocera (Moths)
Order Colepotera (Beetles)
  Family Tenebrionidae (Darkling Beetles)
  Family Carabidae (Ground Beetles)
  Family Elateridae (Click Beetles)
  Family Silphidae (Carrion Beetles)
  Family Buprestidae (Metallic Wood Boring Beetles)
Order Colepotera (Beetles)
  Family Tenebrionidae (Darkling Beetles)
  Family Carabidae (Ground Beetles)
  Family Elateridae (Click Beetles)
  Family Silphidae (Carrion Beetles)
  Family Buprestidae (Metallic Wood Boring Beetles)
Order Diptera (Flies)
Order Hymenoptera (Wasps, Ants, Bees)
  Family Formicidae (Ants)
    Superfamily Apoidea (Bees)
    Superfamily Vespoidea (Vespid Wasps)
    Superfamily Spechoidea (Sphecid Wasps)
Order Araneae (Spiders)
  Family Lycosidae (Wolf Spiders)
Order Solfugae (Windscorpions)

The total number of arthropods trapped in the lower canyon was 2,726. The order Hymenoptera accounted for 91% of the arthropods collected (mostly ants). The next largest order collected were the Hemiptera, mostly boxelder bugs comprising 29% of the total number caught.

The total number trapped in the upper canyon was 2,316. Ninety-one percent of the arthropods captured were Hymenoptera (mostly ants) with the second most common being the Orthoptera (crickets and grasshoppers).

Participants were able to use the data to graphically compare the two trapping areas (see Figure 2). The participants completed their reports. Various ideas concerning the data were discussed.

2.2 Forest Inventory

Very basic to an ecological monitoring program is the understanding of the vegetation component of an ecosystem. The numbers and types of plant species in a habitat will determine the types and numbers of animal species (e.g., birds, mammals, insects). This further leads to discussions about human interaction in the environment and the ecosystems available to animal life. Discussions of contaminant effects, the influence of fire and fire suppression, and management strategies of an ecosystem can be an outgrowth of understanding the vegetation present.

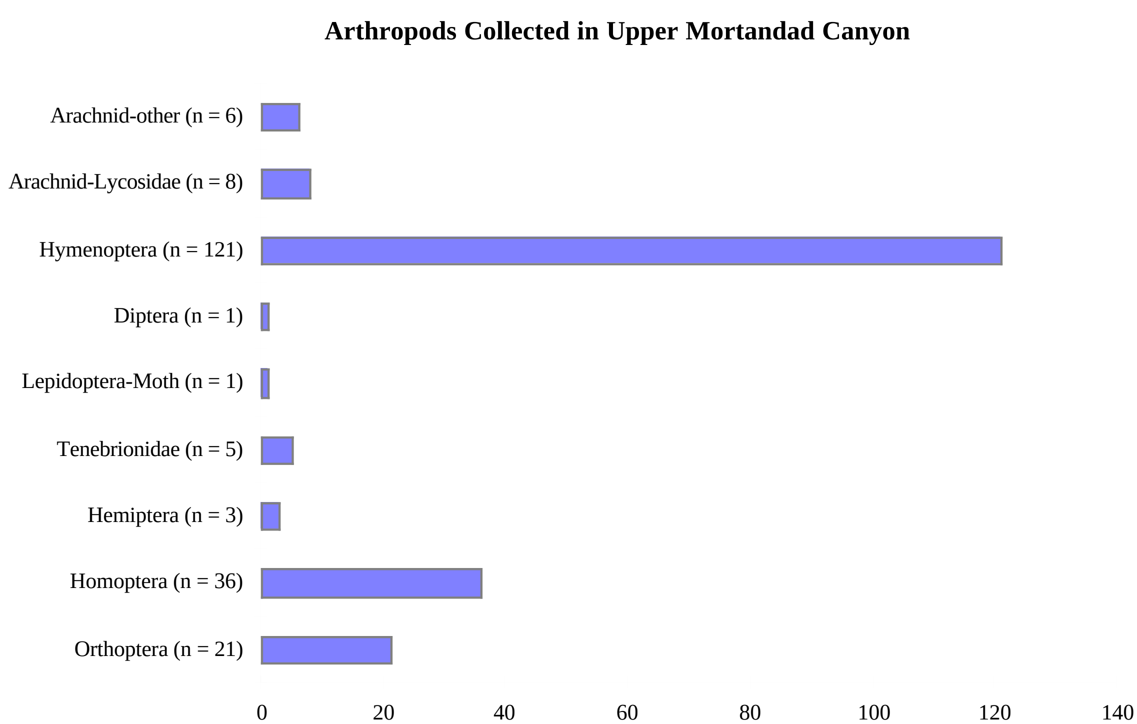


Figure 2. Example of Student Work for Arthropod Sampling Activity

Plant data is easily obtained with the use of low-cost equipment. Using plant data collected, the student can practice and develop mathematic and statistic skills. Additionally, they can develop computer skills through the use of simple graphics software and writing skills in the presentation of data.

2.2.1 Description of the Site

For the field exercise, we took the students to a ponderosa pine cover type. A small drainage at the site had other species such as Douglas fir. Various shrubs including oak were present.

When we examined this site it was apparent that a small 1/8-acre patch had recently burned, and the flush of new growth had begun. This offered the opportunity to talk about fire and fire suppression. This was timely since a 16,000-acre fire had recently been contained 6 miles from the site. We also were then able to take participants to an area that had burned 18 years previously to look at succession.

2.2.2 Methods

There were three components to this exercise: (1) identification of the trees present at the site, (2) measurement of the trees, and (3) discussion of the ecology of the trees.

Identification of trees: The identification of the trees at the site were made using taxonomic keys, *Flowering Plants of the Southwestern Woodlands*, developed by Foxx and Hoard. An introduction to the keys had been previously made in the classroom.

Measurement of trees: Once the trees were identified, we divided the students into groups of six. Each group then measured a different stand within the forest.

Using 200 ft tapes, we had the students stretch the tape through the trees, walking in a straight line. Then we teamed the students in groups of two. Two students measured the trees along the line within 10 ft of either side of the line (Figure 3). Two students measured the cover by an aerial projection of the canopy cover over the line. The remaining students recorded the information.

The students then brought the information into the classroom and summarized the data calculating trees per acre, size of trees, and percent cover of trees.

2.2.3 Discussion of the ecology of the area

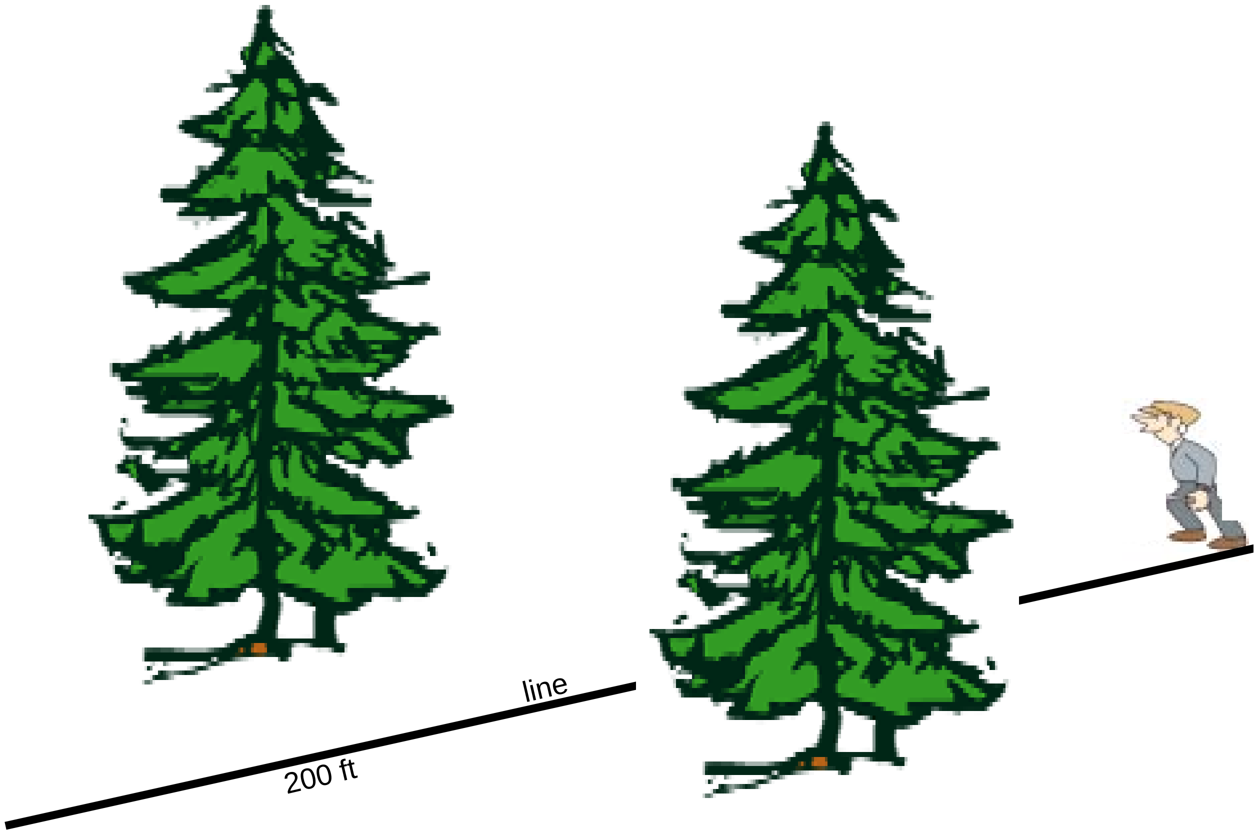
There was a brief discussion of the plant communities in the area and the components of those communities. Serendipitously, the site picked had a small fire sometime within the past month. Using that site, the plant ecologist was able to discuss the importance of fire in the ecosystem.

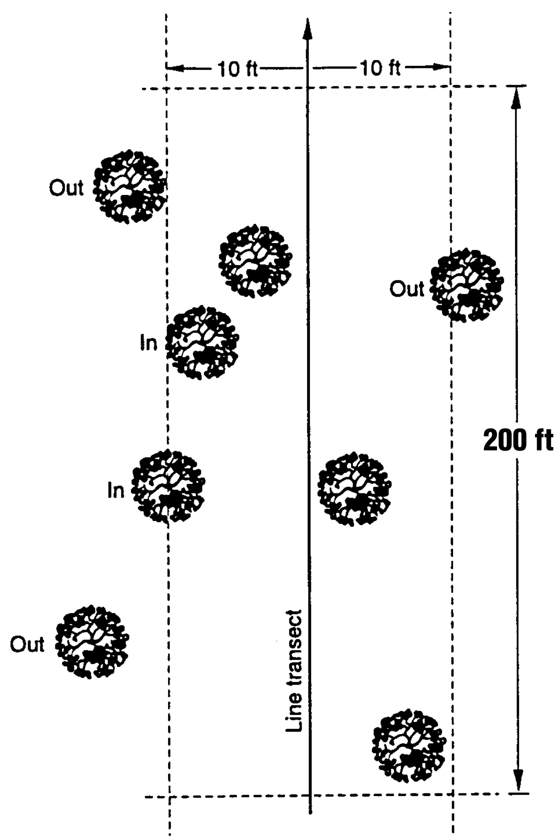
2.2.4 Results

Table 1 and Figure 4 show samples of the results of the calculations made from the data collected. Students were able to determine the tree types, the tree sizes, and the percent cover. The discussion about fire ecology led to some papers and further researching of the importance of fire in the ecosystem.

2.3 Use of Computer Technology

The use and dependence on computers and associated technologies and the relationships to ecological monitoring was shown to be a crucial component of the day-to-day work of scientists. In this institute, communicating scienctific research was accomplished through use of the internet, generation of graphics, and compilation of technical reports.





Tree trunks or stems should be counted in when 50% or greater of the bole or stem is in the plot

Figure 3. Line transect method of tree trunk measurements and stem counts.

Table 1. Example of Student Work for Site Comparison Study

Site#	# of Species	Diversity <4"	Diversity >4"	Canopy Cover
1	2	96% Pondersosa 3% Douglas fir	100% Ponderosa	52%
2	1	100% Ponderosa	100% Ponderosa	54%
2	1	100% Ponderosa	75% Ponderosa 25% Oak	53%
2	1	100% Ponderosa	0%	80%
2	1	100% Ponderosa	25% Oak 7% Douglas fir 4% Limber pine 7% White fir	44%

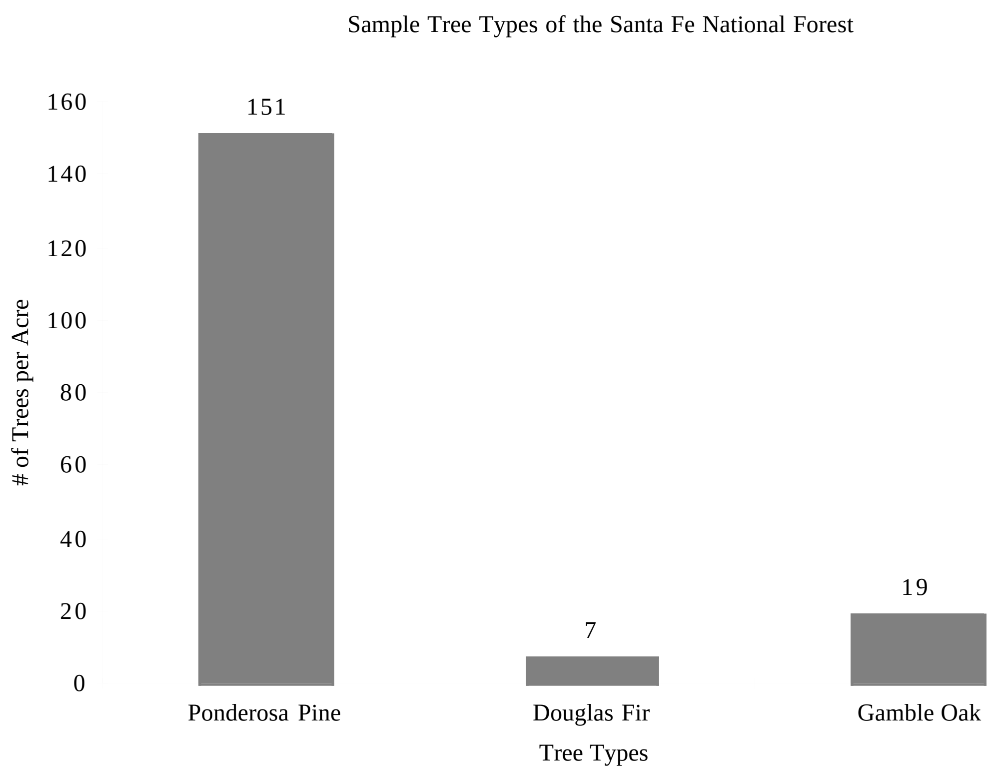


Figure 4. Example of Student Work for Tree Sampling Activity

2.3.1 Internet as a Research Tool

Following the field experiences, the participants spent a few hours surfing the Internet. Through self-identification, only four of the participants admitted to previous experience using the Internet, even though they all acknowledged that this is an important life skill for our students to know. The purpose of this computer activity was to have each person sit at a personal computer, learn how to log onto the Internet, experience the versatility of search engines, find information links that relate to the arthropod and forest sampling activities, and look at the presentation techniques that display technical information.

2.3.2 Technical Reports

Titles of the technical reports produced by teams of institute participants follow:

Pajarito Canyon Forest Tree Data Report
Fire: The Force is With Us!
Diameters of Ponderosa Pines
Tree Suppression
Amazing Ants
Insects of the Southwest
Insect Research
SIMSE Institute - Reporting Environmental Data
Tallying Arthropods from Mortandad Canyon with Relevancy to Mathematics and Science Standards

Following the research on the Internet activity, teams of the institutes participants began work on technical reports. First, the computer specialist taught them how to create a simple spreadsheet and use it to create a bar graph. The teams each picked a data set from the field work, generated graphs, wrote a research summary which included information from the Internet search, and pasted together an electronic version of their technical reports. The quality was quite impressive considering that less than two-days time was involved.

2.4 Journal Entries

Throughout the institute, participants wrote journal entries. These focused on integrating environmental sampling into their classrooms and describing how their view of the what the Laboratory workers do has changed through experiences during the institute. Samples of journal entries follow in the Internet as a Research Tool and Impact of Institute sections of this paper. The specific topics for the journals were the following:

- Describe how your past experiences with SIMSE have changed your teaching/ school;
- Comment on the two environmental field experiences;
- Comment on today's experience with the Internet; and
- How has being at The Laboratory changed your initial impression of this Laboratory?

A sampling from participants' journals provided the following feedback related to their field work activities:

- "This morning as we collected our insects from the two different sites; it was immediately obvious that our collections were diverse. This activity provides a wonderful opportunty for discovery and prediction – species types and numbers."
- "These types of outings provide students with an opportunity to connect with nature. The structures and functions of living systems can definitely be observed. Also the diversity and adaptation of organisms can be observed in their natural habitats."

Evidence from journal entries revealed that most participants were amazed at the quantity, quality, and ease of use of the Internet as a research tool. Journals stated that

- "The Internet offers a great opportunity to follow up our field research and further inquire into various aspects of our study of insects, plants, and fire ecology."
- "The information is endless, and I believe this is a way to teach students to investigate and find information for themselves."
- "This is the first time I have used Netscape. Doing something like this always makes you remember how the kids feel when learning new concepts."

3.0 Discussion of the Impact of Institute

The Laboratory is continually improving communication with the surrounding community, and particularly when that communication deals with environmental surveillance. The summer institute was an effective way to involve educators in hands-on experiences with forest and insect monitoring. This, in turn, taught those educators about the extent of environmental monitoring. Now those teachers are using their experiences to develop curriculum for students. Excerpts from participant journals follow:

- "My views have been expanded exponentially each day we were here! I learned that environmental science is a very hands-on process that takes everything into account. It is the fabric that weaves everything together. I also learned that all the different areas of science entwine to figure out answers to common problems. I always made connections between math & real life & the environment but never before this week did I realize how pertinent science is in EVERYTHING we do!"
- "Science becomes real when someone goes out and does it."
- "The things that have been shown and explained to us I have found fascinating. I guess I never really though of scientists as people who go out in the field and actually study insects and animals as an effect on the environment. I knew somebody did it, I just never associated it with scientists."
- "When I first came up to Los Alamos I wasn't really sure what to expect about the Lab. I had heard some stories about all the secret stuff that was supposed to be up here. But as we worked and listened to all of the presenters, I felt a lot better about Los Alamos. What I really found out is how the Lab tries its best for all the people, environment, and wildlife."

By the end of the week-long institute, the combination of written entries in participant journals and group discussions provided evidence that all five of the goals were met. Scientists led two field experiences and made certain these experiences mirrored their actual field work. The final set of journal entries revealed an increased awareness of the breath and scope of the Laboratory's environmental monitoring program. The professional standards for science and mathematics education were linked to the institute activities. Computers were used for conducting research, creating graphics, and completing written technical summaries. Educational environments were created. This institute was an effective way for Los Alamos National Laboratory to improve communication with its surrounding community and to have educators understand the extent of environmental monitoring that is conducted.

Acknowledgments

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References

D.J. Borror & R.E. White, *The Peterson Field Guide Series: A Field Guide to Insects, America North of Mexico*, Houghton Mifflin Company, Boston, MA (1970).

T.S. Foxx & D. Hoard, *Flowering Plants of the Southwestern Woodlands*, Otowi Crossing Press, Los Alamos, NM (1995).

National Council of Teachers of Mathematics, *Curriculum and Evaluation Standards for School Mathematics*, National Council of Teachers of Mathematics, Inc., Reston, VA (1989).

National Research Council, *National Science Education Standards*, National Academy Press, Washington, DC (1996).